Duke Energy

H. B. Barron
Vice President

Duke Energy Corporation
McGuire Nuclear Station
12700 Hagers Ferry Road
Huntersville, NC 28078-9340
(704) 875-4800 OFFICE
(704) 875-4809 FAX

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U.S. Nuclear Regulatory Commission
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Subject: McGuire Nuclear Station, Unit 1
Docket No. 50-369
Licensee Event Report Number 369/00-04, Revision 0
Problem Investigation Process No. M-00-1899

Pursuant to 10 CFR 50.73 Sections (a) (1) and (d), attached is Licensee Event Report 369/00-04, Revision 0 concerning a McGuire Unit 1 event that resulted in an unplanned valid actuation of an Engineered Safety Feature (ESF) and the Reactor Protection System (RPS). This event was initially reported on May 25, 2000 as per the requirements of 10 CFR 50.72 (b) (2) (ii). This Licensee Event Report is being submitted in accordance with 10 CFR 50.73 (a) (2) (iv).

On May 25, 2000, the output switch on Unit 1 vital inverter 1EVIA failed to the open position, eventually resulting in a Unit 1 reactor trip due to a Low-Low Level on the 1C Steam Generator (RPS actuation). Upon receipt of subsequent Low-Low steam generator level signals, the 1B Motor Driven Auxiliary Feedwater (CA) Pump and the Turbine Driven CA Pump auto-started (ESF actuation). This report also describes post-trip operator actions that resulted in auto-alignment of the ESF CA pumps suction supply from non-safety related water tanks to the assured source (ESF actuation). Duke currently has modifications underway to install a single large volume auxiliary feedwater tank on each McGuire unit. These modifications will reduce operator burden following reactor trips and reduce the potential of inadvertent swap of CA to the safety source.

This event is within the design basis of the plant and represented minimal risk to public health and safety. The planned corrective actions in this LER are regulatory commitments.

H. B. Barron, Jr.
McGuire Site Vice President
Duke Energy Corporation

IE22

cc: Mr. L. A. Reyes
U.S. Nuclear Regulatory Commission
Region II
Atlanta Federal Center
61 Forsyth St., SW, Suite 23T85
Atlanta, GA 30323

F. Rinaldi
U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D.C. 20555

INPO Records Center
700 Galleria Parkway
Atlanta, GA 30339

Mr. Scott Shaeffer
NRC Resident Inspector
McGuire Nuclear Station

NRC FORM 366 U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104
EXPIRES 04/30/98

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS MANDATORY INFORMATION COLLECTION REQUEST: 50.0 HRS. REPORTED LESSONS LEARNED ARE INCORPORATED INTO THE LICENSING PROCESS AND FED BACK TO INDUSTRY. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (T-6 F33), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
McGuire Nuclear Station, Unit 1	05000 369	1 of 9

TITLE (4) McGuire Unit 1 reactor trip resulting in an unplanned valid actuation of an Engineered Safety Feature (ESF) and the Reactor Protection System (RPS).

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER(S)
05	25	00	00	- 04	- 0	06	26	00	None	N/A

OPERATING MODE (9)	1	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR (Check one or more of the following) (11)					
		20.402(b)	20.405(c)	X	50.73(a)(2)(iv)		73.71(b)
POWER LEVEL (10)	100%	20.405(a)(1)(i)	50.36(c)(1)		50.73(a)(2)(v)		73.71(c)
		20.405(a)(1)(ii)	50.36(c)(2)		50.73(a)(2)(vii)		OTHER (Specify in
		20.405(a)(1)(iii)	50.73(a)(2)(i)		50.73(a)(2)(viii)(A)		Abstract below and
		20.405(a)(1)(iv)	50.73(a)(2)(ii)		50.73(a)(2)(viii)(B)		in Text, NRC Form
		20.405(a)(1)(v)	50.73(a)(2)(iii)		50.73(a)(2)(x)		366A)

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER	
	AREA CODE	
Julius W. Bryant	(704)	875-4162

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS *	
X6	EF	JS	G080	Y							

SUPPLEMENTAL REPORT EXPECTED (14)			EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE)	X	NO				

ABSTRACT (Limit to 1400 spaces, i.e. approximately fifteen single-space typewritten lines) (16)

Unit Status: At the time of the ESF/RPS actuation, both Unit 1 and Unit 2 were in Mode 1 at 100% Power.

Event Description: On May 25, 2000, Unit 1 experienced a failure of the output switch on vital inverter 1EVIA. This failure caused a loss of Channel 1 vital instrumentation and control power resulting in a false low Channel 1 steam generator (S/G) level input to the S/G Water Level Control System, commencing a feedwater system transient. Upon placing S/G water level control in Channel 2, the feedwater system transient continued in a manner which resulted in a trip of the 1A CF Pump due to high discharge pressure, followed by a Unit 1 reactor trip due to 1C S/G Low-Low Level. Upon receipt of subsequent Low-Low S/G Level inputs, the 1B Motor Driven Auxiliary Feedwater (CA) Pump and the Turbine Driven CA Pump auto-started. The 1A Motor Driven CA Pump was manually started, as it did not auto-start since its control circuitry is supplied power from Channel 1 vital control power, which was lost. In addition, post-trip operator actions resulted in the auto-alignment of the CA pumps suction to the assured source when the normal non-safety related water supplies were isolated.

Event Cause: Mechanical related failure of the 1EVIA inverter output switch. Failure to correctly follow procedure when aligning CA pump suction sources.

Corrective Action: Replaced vital inverter switches as needed. Future modifications will eliminate switches of this design. Plant procedures revised to preclude inadvertent alignment of CA pump suction to the assured source. Operator training (RO only) will be reviewed to examine proficiency in the use of 2 column format procedures as related to this event.

NRC FORM 366 *NPRDS no longer exists, equipment failures will be reported through EPIX

BACKGROUND

The following summary descriptions of Unit 1 equipment and functions are relevant to discussion of the subject event.

S/G Water Level Control Description:

The Unit 1 S/G Water Level Control System maintains constant S/G level as determined by a programmed level. The system consists of four redundant channels of S/G narrow range level instrumentation per S/G. Channel selection is accomplished using a switch on the main control board in the Control Room. System control circuitry receives electrical power from the Unit 1 120 VAC Vital Instrumentation and Control Power System. Each narrow range level channel supplies input to the RPS and the Engineered Safety Features Actuation System (ESFAS) to accomplish the following automatic functions:

- Reactor trip on Low-Low S/G level (RPS function).
- ESF actuation on Low-Low S/G level.
- ESF actuation on Hi-Hi S/G level.

In addition, one narrow range level channel (of two selectable on the main control board) per S/G supplies input to the CF regulating valves, which open and close as needed to maintain S/G levels at the programmed level.

120 VAC Vital Instrumentation and Control Power System Description:

The McGuire Unit 1 120 VAC Vital Instrumentation and Control Power System supplies uninterrupted AC power at sufficient voltage and with sufficient capacity to safety related instrumentation and control equipment required for normal plant operation, the safe shutdown of the facility, and the mitigation and control of accident conditions within the facility during normal plant operation and during various design basis events. The system includes four vital inverters which provide power to four panelboards. These panelboards supply power to four independent channels of Unit 1 instrumentation and control power (see below).

	Channel 1	Channel 2	Channel 3	Channel 4
Inverter	1EVIA	1EVIB	1EVIC	1EVID
Panelboards	1EKVA	1EKVB	1EKVC	1EKVD

Complete physical and electrical separation and independence is maintained between components and circuits of the four redundant channels so that a single failure at any point in any one of the four channels does not disable more than one vital channel.

CF System Description:

The McGuire Unit 1 CF pumps take suction from the discharge of the Condensate System and supply water to the S/G's. A CF regulating valve, located in each S/G feedwater supply line, receives input from the S/G Water Level Control System and modulates as needed to control level in the respective S/G. Pressure transmitters in the discharge piping of each CF pump trip these pumps on high discharge pressure (2 out of 3 logic).

CA System Description:

The McGuire Unit 1 CA System supplies auxiliary feedwater to the S/G's when the CF system is unavailable to maintain S/G water inventory. This ESF function provides a means of dissipating energy from the Reactor Coolant System. The CA system operates until normal feedwater flow is restored or the reactor coolant temperature is lowered to the point where the Residual Heat Removal System can be utilized.

To accomplish the above function, one turbine driven and two motor driven pumps are provided. The motor driven CA pumps will auto-start upon receipt of two out of four Low-Low narrow range level alarms in any one S/G (ESF feature). The turbine driven CA pump will auto-start upon receipt of two out of four Low-Low narrow range level alarms in any two S/Gs (ESF feature).

The CA pumps have the following sources of water available to them: Auxiliary Feedwater Condensate Storage Tanks (CACST), the Upper Surge Tanks (UST), Main Condenser hotwell, and the Nuclear Service Water (RN) System. The Turbine Driven CA Pump can also be supplied from the Recirculation Water (RC) System via RN.

The USTs, CACSTs, and Main Condenser hotwell are considered non-safety related. The Main Condenser hotwell is normally isolated from the CA pumps, but can be aligned, if required. 1CS18 is a normally open valve located between the USTs and the CA pumps. 1CA6 is a normally open valve located between the CACSTs and the CA pumps.

The RN system provides the safety-related source of water and is considered the assured water source under design basis accident scenarios. The CA water source automatically switches from the non-safety related sources to the assured RN source on low CA suction pressure (ESF feature).

EVALUATION

Description of Event

At the time of the event on May 25, 2000, Unit 1 was in Mode 1 at 100% power. All the emergency core cooling systems and the emergency diesel generators were fully operable if needed. The following is an approximate timeline of the event:

20:43:30 Failure of the output switch on vital inverter 1EVIA. This failure caused a low voltage on the 1EKVA inverter panelboard resulting in a loss of Channel 1 vital control power. This caused a false low Channel 1 S/G level input to the S/G Water Level Control System.

20:43:35 Due to the false low S/G level signal, the Unit 1 CF regulating valves went full open.

20:43:39 Unit 1 CF pump suction pressure Lo and Unit 1 Condensate Booster pump suction pressure Lo alarms were received due to opening of CF regulating valves. Unit 1 standby Condensate Booster pump and Main Condenser hotwell pump started. Control rods placed in manual as required by the immediate actions of AP/1/A/5500/15 ("Loss of Vital or Auxiliary Control Power").

20:43:43 Unit 1 S/G water level control was placed in Channel 2 as per plant procedures. CF regulating valves went closed or nearly closed in response to a valid S/G water level signal which indicated that S/G water levels were higher than the programmed level setpoints.

20:43:59 Trip of the 1A CF pump due to high discharge pressure caused by the feedwater system response not being quick enough to reduce flow capacity as rapidly as the CF regulating valves reduced flow demand. Unit 1 begins 50% load rejection.

20:44:02 CF regulating valves began to open.

20:44:23 Primary system Power Operated Relief Valves (PORV) 1NC32 and 1NC36 momentarily opened and subsequently closed. At the time of the runback, the Unit 1 control rods were in manual and the capability to automatically drive the rods in was not available. As a result, reactor coolant system pressure increased enough to momentarily open the above two PORVs. The third primary PORV, 1NC34, did not open because its control power was fed from Channel 1 of the 120 VAC Vital Instrumentation and Control Power System, which was lost. No code safety valves on the primary side and no PORVs or code safety valves on secondary side of the plant opened.

20:46:10 Unit 1 reactor tripped on 1C S/G narrow range Low-Low level (RPS actuation). All rods fully inserted into the core and reactor coolant temperature was maintained at the Tave no load condition of 557 degrees Fahrenheit.

20:46:11 1B Motor Driven CA Pump auto-started in response to Low-Low S/G levels (ESF actuation).

20:46:31 Turbine Driven CA Pump auto-started in response to Low-Low S/G levels (ESF actuation).

20:46:53 1A Motor Driven CA Pump manually started (ESF actuation). The 1A Motor Driven CA Pump did not auto-start on Low-Low S/G levels since its automatic control circuitry is supplied power from Channel 1 of the 120 VAC Vital Instrumentation and Control Power System, which was lost.

21:27 1CS18 was closed. This isolated the USTs supply to the Unit 1 CA pumps.

21:57 1CA6 was closed, isolating the CACSTs supply to the Unit 1 CA pumps. This isolated the remaining non-safety related water supply to the Unit 1 CA pumps, which caused a low suction pressure condition. The Unit 1 CA pumps supply auto-aligned to the assured RN source due to low CA pump suction pressure (ESF actuation).

21:58 1CA6 was opened, restoring the CACSTs supply to the Unit 1 CA pumps. The assured RN supply to the CA pumps was isolated (except for the Safe Shutdown Facility assured RN supply to the pumps).

22:09 1CS18 was opened, restoring the USTs supply to the Unit 1 CA pumps.

22:10 1CA6 was closed, isolating the CACSTs supply to the Unit 1 CA pumps. The Safe Shutdown Facility assured RN supply to the CA pumps was isolated.

Cause of Event

Reactor Trip/CA Pump Starts:

The cause of the Unit 1 reactor trip (RPS actuation) and start of the CA pumps (ESF actuation) was mechanical related failure of the manually operated output switch on vital inverter 1EVIA.

A post-event investigation determined that the vital inverter 1EVIA output switch failed due to mechanical failure, which prevented the switch from fully latching in the closed position. This allowed the switch to open, initiating the events leading to the reactor trip and ESF actuation. Contributing causes of the reactor trip related to feedwater controls circuit and operator responses have yet to be fully determined at the time of the submittal of the LER.

Auto-Alignment of The Unit 1 CA Pumps To The Assured RN Source:

The post-event investigation determined that auto-alignment of the Unit 1 CA pumps to the assured RN source (ESF actuation) occurred when operators failed to correctly implement the required actions in procedure EP/1/A/5000/G-1, Generic Enclosure 20 ("Maintaining CA Suction Sources"). Approximately 30 to 40 minutes after start of the CA pumps, operators began implementation of this enclosure to ensure that an adequate non-safety related suction source was available for the CA pumps.

Step 4 of Enclosure 20 directs the operator to monitor level in the USTs. If UST level indication is functioning and indicating adequate level in the tanks, then the remaining actions of Step 4 are not performed and the operator is to then proceed to Step 5 of the Enclosure.

However, if UST levels are inadequate or level indication is lost, the remaining actions of Step 4 direct the operator to verify the CACSTs are aligned to the CA pumps, confirm the CACSTs contain adequate water, and then isolate the USTs by closing 1CS18.

Step 5 of Enclosure 20 directs the operator to monitor level in the CACSTs. If CACST levels are adequate, then the remaining actions of Step 5 are not performed and the operator is then directed to proceed to Step 6 of the Enclosure. However, if CACST levels are inadequate, the operator is to then verify the USTs are aligned to the CA pumps, confirm the USTs contain adequate water, and then isolate the CACSTs by closing 1CA6.

Confusion in interpreting the steps in Enclosure 20 resulted in operators isolating both the CACST and UST as suction sources for auxiliary feedwater. This isolation resulted in low CA pump suction pressure and subsequent auto-alignment of the CA pump suction to the assured RN source. Operators recognized the low suction pressure condition and restored CACST as the suction source. Restoration of the CACST as the suction source occurred within approximately one minute after the swap to RN. The auto-swap is a design safety feature intended to protect the CA pumps from low suction pressure as the CACST and UST inventories near exhaustion during design basis events. An automatic swap will occur, absent action taken by operators to prevent these tanks from exhausting their inventory.

Feedwater Isolation

Due to the feedwater system transient and drop in steam generator levels there were automatic starts of the motor driven auxiliary feedwater pump "B" and turbine driven auxiliary feedwater pump. The "A" motor driven auxiliary feedwater pump was started manually because the auto-start capability was lost on the failure of the Channel I Vital Inverter. The auxiliary feedwater pumps ran from approximately 20:46 and were throttled at approximately 21:00 after steam generator levels had recovered to normal operating ranges for post trip conditions.

The auxiliary feedwater caused a cooldown of the reactor coolant system as a normal plant response until the reactor coolant reached the setpoint of 553 F ^{0}. At that time there was a feedwater isolation, however that did not interrupt the flow of auxiliary feedwater to the steam generators. This response is not an unexpected result from a reactor trip associated with low steam generator levels. Once steam generator levels reached the normal operating range for hot standby the auxiliary feedwater flow was throttled and the reactor coolant system

temperature returned to the normal operating range. The minimum reactor coolant system temperature was approximately 548 F°

CORRECTIVE ACTION:

Immediate

1. Replaced the failed output switch on Unit 1 vital inverter 1EVIA.
2. Replaced the output switch on Unit 1 vital inverter 1EVID. Note that no problems were observed with the 1EVID switch. Its replacement was performed as a conservative measure since it is a similar model switch as the failed switch on 1EVIA. The remaining Unit 1 vital inverter switches and the switches for Unit 2 vital inverters 2EVIB and 2EVIC were not replaced since no problems were observed with these switches and they are a different model from the failed 1EVIA output switch. Note that the output switches for the remaining Unit 2 vital inverters (2EVIA and 2EVID) are similar to the failed 1EVIA switch. However, since no problems have been observed with these two Unit 2 switches and to preclude any Unit 2 plant transients, they were not replaced at this time. The inverters were already scheduled for replacement in a refueling outage in the fall of 2000.
3. EP/1/A/5000/G-1, Generic Enclosure 20 ("Maintaining CA Suction Sources") was revised to clarify requirements and help preclude inadvertent alignment of the CA pump suction to the assured RN source.

Planned

1. Future modifications are planned to replace all Unit 1 and 2 vital inverters. These new inverters will not use the same switches as the failed 1EVIA output switch.
2. Operator training (RO only) will be reviewed to examine proficiency in the use of 2 column format procedures as related to this event.
3. A review of feedwater related control settings and operator responses will be undertaken to determine if any changes are necessary to improve overall plant level response to vital inverter failures.
4. A review of the McGuire simulator will be undertaken to determine if it can more effectively represent plant response and the effect of operator actions following a loss of a vital inverter.

SAFETY ANALYSIS:

Based on this analysis, this event is not considered to be significant. At no time were the safety or health of the public or plant personnel affected as a result of the event.

A reactor trip caused by a loss of normal feedwater flow is analyzed in Chapter 15 of the McGuire Nuclear Station Final Safety Analysis Report. The accident analysis demonstrates that, given the assumptions and sequence of events described in Chapter 15, the plant design and response is adequate and therefore such an event presents no hazard to the integrity of the reactor coolant system or the reactor fuel/cladding. The actual reactor trip is bounded by the UFSAR design basis event (15.2.7 "Loss of Normal Feedwater") which evaluates a total loss of normal feedwater flow and a failure of the turbine drive auxiliary feedwater pump. Despite the failure of the 1A Motor Driven CA Pump to auto-start due to the vital inverter failure, it was started manually providing CA flow from all three pumps to all four generators.

The safety analysis discussion in the LER will evaluate the impact of this event on conditional core damage probability. Probabilistic Risk Analysis (PRA) of the subject event incorporating the auto-alignment of the CA pumps suction to the assured RN source was performed using the McGuire Nuclear Station Revision 2 model. This event was analyzed as a loss of feedwater/reactor trip with a failure of the 1EKVA Transfer Switch and a swap of the CA suction sources to RN. The dominant core damage sequences consist of a loss of feedwater with reactor trip, swap of the CA suction source to RN, common cause failure of the CA suction from RN, failure to recover main feedwater, and failure of feed and bleed cooling.

The conditional core damage probability for this event has been calculated to be 6.65E-06. From revision 2 of the MNS PRA analysis, the major contributor to Large Early Release Frequency (LERF) is Interfacing Systems LOCAs (approximately 99.8%). This event does not produce sequences that contribute significantly to the ISLOCA plant damage state. The impact on LERF is therefore very small.

Given the above, this event is considered to be of no significance with respect to the health and safety of the public.